# Design of Intelligent Pet Feeder Based on Kano & AHP

**Dehui Ye[1], Fanglin Du[2*]**

**[1] School of Electronic Technology, Guilin University, China**

**[2] School of Electronic Technology, Guilin University, China**

***Corresponding author, e-mail: 641204622@qq.com**



**Abstract:** In order to objectively understand the types of pet users' needs, tap potential product functions and improve users' satisfaction with products. The research method combining Kano model and AHP is used for comprehensive evaluation, and the optimal scheme is obtained. Firstly, the hierarchical needs of users for product functions are divided through Kano model. Secondly, combined with AHP, the demand evaluation index framework is constructed, the weight index is prioritized, and the most expected functional attributes of users are revealed. Finally, the scheme is designed according to the optimal demand index. The results show that the research method of Kano & AHP model can effectively analyze users' implicit needs accurately and standardized from the perspective of users' needs, It provides a reference for the design and development of such products.

**Keywords:** Intelligent products, functional requirements, pet feeder, Kano Model

## 1. Introduction

With the increase of pet raising population in China [1], more than 70% of pet owners have a bachelor's degree or above, and the proportion of pet raising women is greater than that of men, of which 68.5% are women and 31.5% are men. Most of them are aged 18-35. There are more women, and the types of goods and services related to pet consumption are constantly enriched. Due to the large market demand, the development and design of intelligent pet feeder has gradually become the focus of pet consumption related goods. Through research, it is found that pet users are less satisfied with such products. Therefore, it is very necessary to take users as the center, accurately divide the types of user needs, build objective evaluation indicators, and design products that meet the needs of users.

## 2 .Literature Review

At present, scholars study the intelligent pet feeder from four aspects: system automatic feeding, intelligent monitoring, intelligent technology and pet "emotional level". Dr. devika B [2] has developed an intelligent pet monitoring and feeding system. The owner can remotely set the

pet feeding time, quantity and food through the mobile phone. M. K Razali et.al [3] developed an intelligent pet monitoring system with big data processing function to analyze the data of pet consumption level and give feeding suggestions. Wu, Wen Chuan [4] designed a remote control system to monitor pet movement through mqtt protocol. Petcube bites PET camera [5] users can set feeding time by remote control, throw out food, interact with pets and send it to social networks to share with friends. Sun Menglu [6] explained that in the pet information industry, pet products [7] about intelligent monitoring, intelligent collar and intelligent furniture have sprung up. Xia Jinjun proposed to integrate intelligent pet products and emotional ideas for design from the perspective of emotional design, trying to use design to reduce the sense of alienation between scientific and technological products and people, and create an intelligent machine that moves people [8]. Through literature review, it is found that there are several deficiencies in the design and research of intelligent pet feeder.one. Scholars focus on Intelligent feeding system.two, There is also relatively little research on product and emotional design [9]. three, It does not mine the needs of users in an objective way from the perspective of users' needs. Therefore, it is of great research significance and value to take users as the center [10] and deeply tap the product design of users' needs



# 3. Method

## 3.1 Method one

Kano model is a mature method and important tool for requirement identification [11]. Kano model theory originated from the two factors the ory put forward by American behavioral scientist redrick zberg in 1959 [12]. In 1984, N. Kano, a famous quality management expert from Tokyo University of technology, further proposed Kano model [13], as shown in Figure 1. Users' satisfaction with the function or service is scored through Kano questionnaire survey, which is divided into five levels: satisfied, natural, indifferent, tolerable and intolerable. Thus, the basic demand (m), expectation demand (o), indifference demand (I) and charm demand (a) of users are analyzed. When the demand is met, user satisfaction will increase or decrease significantly. By calculating the better worth value, the function is divided into necessary attribute, expectation attribute, charm attribute, indifference attribute, reverse attribute and suspicious attribute, so as to further tap the deep-seated psychological needs of users and provide reference for design.

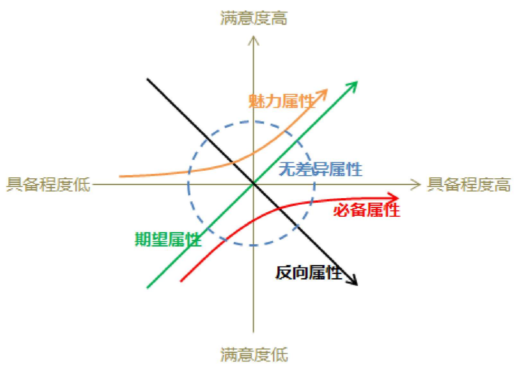


*Figure 1  Kano model*

### 3.2 Method two

American operations research scientist Thomas SETI proposed analytic hierarchy process (AHP) in the 1970s. This method is suitable for studying fuzzy problems that are difficult to quantify. It mainly uses the measurement theory to comprehensively evaluate things restricted by many factors. Its essence is a practical multi criteria, multi scheme or multi-objective decision-making method [14]. The core of analytic hierarchy process is to construct the judgment matrix of importance by comparing various criteria factors by industry experts. Therefore, with the help of Kano model and AHP analytic hierarchy process, a scientific analysis method is established, which can divide different demand weights and provide reference for the design scheme. The specific steps are as follows:

Establish a hierarchical model.

Construct judgment matrix.

$$M' = \begin{bmatrix} 1 & 2 \\ \frac{1}{2} & 1 \end{bmatrix}$$

Normalize the elements in matrix  according to columns.

$$\bar{a}_{ij} = a_{ij} / \sum_{k=1}^{q} a_{kj} \qquad (i, j = 1,2\ldots, n)$$

Add the data in the same row of the normalized matrix and divide it by the order to obtain the weight value of each factor.

$$w_i = \frac{\widetilde{w}_i}{n} = \frac{1}{n} \sum_{j=1}^{n} \bar{a}_{ij} \qquad (i, j = 1,2\ldots, n)$$

Calculate the maximum characteristic root.

$$\lambda \max = \frac{1}{n} \sum_{i=1}^{n} \frac{(A'w)_i}{w_i}$$

Where: $w$ ——Weight vector, = $(w_1, w_2,\ldots,w_n)$; $(A'w)$——vector $A'w$ the first $i$ two components. Consistency inspection; Calculate the maximum eigenvalue of the judgment matrix $\lambda \max$ Consistency index *CI*.

$$CI = \frac{\lambda \max - n}{n-1}$$

Is the dimension of the matrix. The maximum eigenvalue of the consistent matrix is. When the maximum eigenvalue of the judgment matrix is, the judgment matrix is the consistent matrix. According to the size of the, find the average random consistency index RI, as shown in Table 1.

*Table 1　Average Random Consistency Index RI*

| $n$ false | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $RI$ false | 0 | 0 | 0.52 | 0.89 | 1.12 | 1.26 | 1.36 | 1.41 | 1.46 | 1.49 | 1.52 | 1.54 | 1.56 | 1.58 | 1.59 |

Calculate consistency ratio $CR$

$$CR = \frac{CI}{RI}$$

The design framework process is shown in Figure 2:

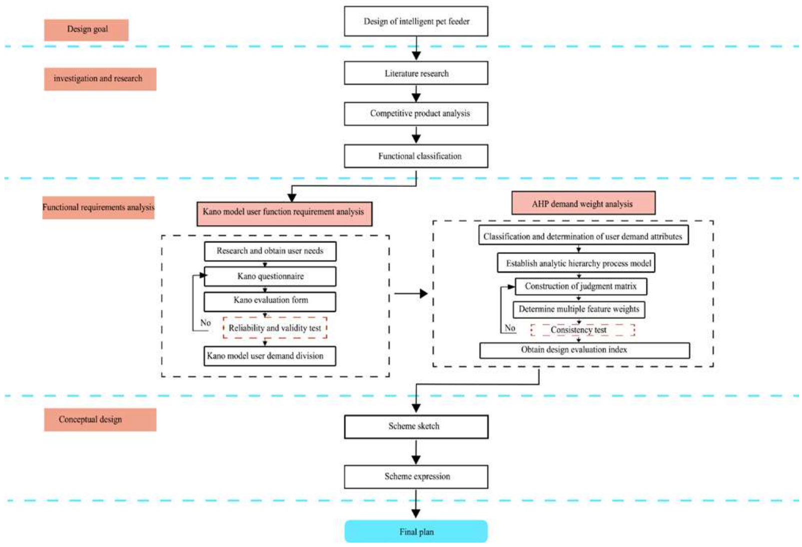


*Figure 2 Design framework flow based on KANO / AHP method*

## 4. Results

Competitive product analysis data through desktop research, user interviews, focus group discussions and other forms, 150 products of 30 different brands used by customers are collected. In order to ensure the objectivity and unity of the sample, 6 brand products with a large number of buyers in the market are finally selected: petkit / Xiaopei, Xiaomi, Linglong cat, Amazon, Donis and paiwang for parameter analysis, shape analysis, color analysis and function analysis and comparison, The comparative analysis shows that the mainstream pet feeders in the market are aimed at small and medium-sized pets; The most common product forms are cuboid and cylinder, followed by disc shape and less trapezoid shape; The products are mainly made of white ABS plastic and metal, and there are few products in color category. In addition to material functions, color is also related to emotional needs and spiritual comfort. Color design should not only meet people's emotional needs, but also meet the aesthetic characteristics and design value orientation in a specific period [15]; The product functions meet the basic feeding function, video function and remote management function, but the development of interactive function and characteristic function is less. According to the product function description of competitive product analysis and the daily common functions of users, we divide the functions of pet feeder into 6 categories: basic function, video function, interactive function, remote management function and characteristic function. The specific functions are divided into 23 function items, as shown in Table 2.

*Table 2 Functional Classification Of Pet Feeder*

| | Classification | Specific functions | Explain |
|---|---|---|---|
| Intelligent pet feeder | basic function | Regular feeding | Feed food to pets regularly |
| | | Regular water feeding | Water your pet regularly |
| | | Preservation function | Keep food fresh |
| | | Visible grain barrel | Surplus grain can be seen |
| | video function | 1080 video recording | Video recording dog behavior |
| | | Infrared night vision | With night vision monitoring |
| | | Ultra wide angle | Ultra wide angle shooting |
| | | High definition | High definition viewing |
| | | Bidirectional voice | Can interact with dogs |
| | interactive function | Pet video trigger | Pet video calling owner |
| | | Frisbee interaction | Interactive games with dogs |
| | | Pet companionship | Play with function |
| | remote management | App timed feeding | App feeding |
| | | Reminder function | reminder feeding |
| | | Cloud storage | Large cloud storage capacity |
| | characteristic | The bowl is easy to clean | easy to clean |
| | | Modular disassembly | Portable products |
| | | Waterproof function | waterproof |
| | | Small floor area (A4) | Small size, no occupied area |
| | | Grain shortage tips | Grain shortage tips |
| | | Regular water change | Automatic water change |
| | | Anti stealing lock key | Prevent stealing food |
| | | Voice calling for food | Voice call pet |

There are 28 questions in Kano questionnaire. Questions 1-5 are the basic information survey of pet feeder users, including user gender, age, years of using pet feeder, frequency and main functions; Questions 6-28 are the main part of the questionnaire. See Table 3 for the classification and comparison of Kano evaluation results. The sample questions of the questionnaire are shown in Table 4.

*Table 3 Comparison Of Kano Model Evaluation Results*

| Functions / services | | This function is not available | | | | |
|---|---|---|---|---|---|---|
| | | dislike | Can bear | indifferent | It should be | like |
| With this function | dislike | Q | R | R | R | R |
| | Can bear | M | I | I | I | R |
| | indifferent | M | I | I | I | R |
| | It should be | M | I | I | I | R |
| | like | O | A | A | A | Q |

A: Charm attribute, O: expected attribute, M: required attribute, I: no difference attribute, R: reverse attribute, Q: suspicious attribute

*Table 4 Sample Questions Of Kano Questionnaire On Functions Of Intelligent Pet Feeder*

| Intelligent pet feeder function | problem | like | It should be | indifferent | Can bear | dislike |
|---|---|---|---|---|---|---|
| Timed feeding function | provide this function | 5 | 4 | 3 | 2 | 1 |
| | this function is not available | 5 | 4 | 3 | 2 | 1 |



The questionnaire was distributed online and offline. Within one week, 165 valid questionnaires were collected, 15 invalid questionnaires were excluded, and a total of 150 questionnaires were collected. As shown in Table 5 for the data.Cronbach's of forward problem tested by SPSS statistical software α The value is 0.828, Cronbach's of the reverse problem α The value is 0 869, all reached more than 0.8, indicating that the questionnaire has good reliability. SPSS 26 statistical software was used to conduct factor analysis on Kano questionnaire of pet feeder function. Kmo = 0.694, greater than 0.5, indicating that it is suitable for factor analysis, and the significant probability of Bartlett sphere test is 0.000, less than 0.01, indicating that the data are correlated. From the frequency statistics, 14 of the 23 demands surveyed are expected demands and 9 are necessary demands, and there are few charm demands, no difference special-shaped demands and reverse demands, indicating that there are no functions that users dislike in the surveyed demand items. Users pay more attention to the expected functions of the product, such as visual grain bucket, fresh-keeping function and small floor area. The reason why users expect this function is that during their use, some products do not have the preservation function, pet food is easy to rot or deteriorate, and the product size of pet feeder is too bulky to carry, so users expect this function. When the demand item is met, user satisfaction is improved. Users pay more attention to the essential functions of the product, such as ultra wide-angle function and infrared night vision function, indicating that users want to monitor pets at night.

*Table 5 Summary Of Kano Model Analysis Results - Digital Results*

| Function yes / no | A | O | M | I | R | Q | Results | Better | Worse |
|---|---|---|---|---|---|---|---|---|---|
| Regular feeding | 17 | 21 | 10 | 2 | 0 | 0 | expected attribute | 76.00% | -62.00% |
| Regular water feeding | 13 | 22 | 12 | 2 | 1 | 0 | expected attribute | 71.43% | -69.39% |
| Preservation function | 11 | 27 | 10 | 2 | 0 | 0 | expected attribute | 76.00% | -74.00% |
| Visible grain barrel | 10 | 29 | 11 | 0 | 0 | 0 | expected attribute | 78.00% | -80.00% |
| 1080 video recording | 6 | 14 | 27 | 2 | 1 | 0 | required attributes | 40.82% | -83.67% |
| Infrared night vision | 4 | 5 | 34 | 4 | 3 | 0 | required attributes | 19.15% | -82.98% |
| Ultra wide angle | 2 | 3 | 34 | 6 | 5 | 0 | required attributes | 11.11% | -82.22% |
| High definition | 2 | 5 | 33 | 4 | 6 | 0 | required attributes | 15.91% | -86.36% |
| Bidirectional voice | 2 | 9 | 29 | 5 | 5 | 0 | required attributes | 24.44% | -84.44% |
| Pet video trigger | 4 | 13 | 23 | 6 | 4 | 0 | required attributes | 36.96% | -78.26% |
| Frisbee interaction | 7 | 19 | 16 | 6 | 2 | 0 | expected attribute | 54.17% | -72.92% |
| Pet companionship | 11 | 19 | 16 | 3 | 1 | 0 | expected attribute | 61.22% | -71.43% |
| App timed feeding | 11 | 14 | 18 | 4 | 3 | 0 | required attributes | 53.19% | -68.09% |
| Reminder function | 10 | 22 | 12 | 5 | 1 | 0 | expected attribute | 65.31% | -69.39% |
| Cloud storage | 13 | 14 | 19 | 3 | 1 | 0 | required attributes | 55.10% | -67.35% |
| The bowl is easy to clean | 15 | 21 | 10 | 3 | 1 | 0 | expected attribute | 73.47% | -63.27% |
| Modular disassembly | 13 | 24 | 10 | 3 | 0 | 0 | expected attribute | 74.00% | -68.00% |
| Waterproof function | 14 | 21 | 12 | 1 | 2 | 0 | expected attribute | 72.92% | -68.75% |
| Small floor area (A4) | 14 | 26 | 7 | 2 | 1 | 0 | expected attribute | 81.63% | -67.35% |
| Grain shortage tips | 15 | 18 | 14 | 3 | 0 | 0 | expected attribute | 66.00% | -64.00% |
| Regular water change | 15 | 18 | 11 | 5 | 1 | 0 | expected attribute | 67.35% | -59.18% |
| Anti stealing lock key | 10 | 13 | 24 | 3 | 0 | 0 | required attributes | 46.00% | -74.00% |
| Voice calling for food | 11 | 23 | 12 | 4 | 0 | 0 | expected attribute | 68.00% | -70.00% |

## 5. Discussion

The analytic hierarchy process model is constructed by combining the user demand attributes divided by Kano model. The target layer is the design scheme of intelligent pet feeder, and the criterion layer is the expected demand o and necessary demand M. the sub requirements under various requirements are expanded to the sub criterion layer. In the sub criterion layer, O1 represents the regular feeding function, O2 represents the regular feeding function, O3 represents the fresh-keeping

function, and so on. See Figure 3 for its framework.

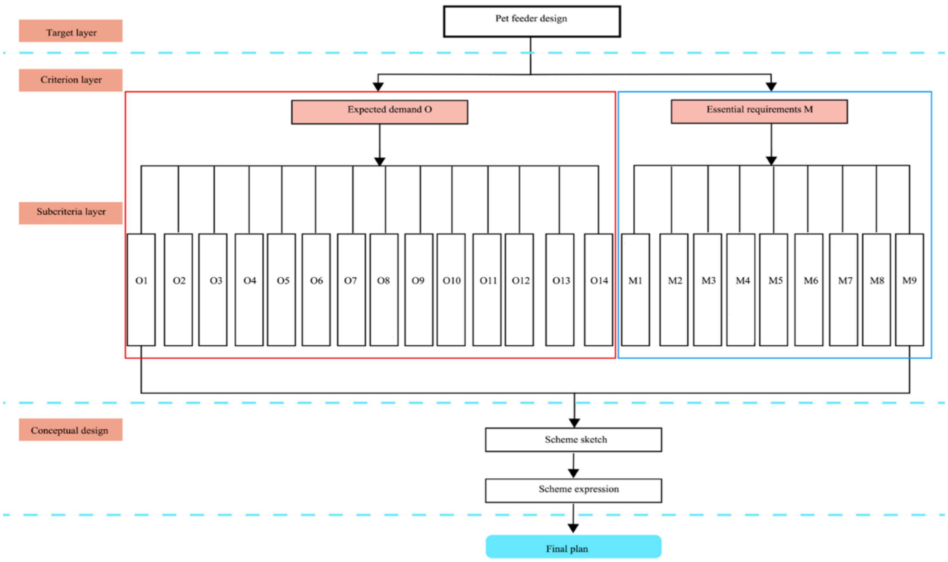


*Figure 3 AHP weight analysis framework*

The AHP questionnaire is made with 1-9 comparison scales, and the important levels are 1 / 9, 1 / 7, 1 / 5, 1 / 3, 1, 3, 5, 7 and 9 respectively. Among them, 15 senior industry experts are investigated,including 5 experts in intelligent pet feeder development, 5 senior designers and 5 masters in product research. Experts in the industry are invited to compare the importance of the expected demand o and the necessary demand m of the questionnaire and evaluate and score them, The average value of the calculation is taken as the weight calculation value. Within a week of distribution, 15 valid questionnaires are recovered, 5 invalid questionnaires are excluded, and a total of 10 questionnaires are collected. According to the steps of geometric average method, the index weight of criterion layer is calculated, as shown in Table 6. The normalized sum of index weight of necessary demand layer is shown in Table 7. The normalized sum of index weight of expected demand layer is shown in Table 8. Cronbach's of 10 experts is tested by SPSS statistical software α The value is 0.941. The consistency test of the judgment matrix results shows that the consistency test is passed (CR ≤ 0.01), as shown in Table 9.

| | **M** | **O** | $\tilde{w}_i$ **false** | $w_i$ **false** |
|---|---|---|---|---|
| M | 0.667 | 0.631 | 1.298 | 0.649 |
| O | 0.333 | 0.369 | 0.702 | 0.351 |
| $\Sigma_{\bar{a}_{ij}}$ false | 1 | 1 | | |

*Table 6 Index Weight Of Criterion Layer*

*Table 7 Sum Of Index Weights Of Essential Demand Layer*

| M | M1 | M2 | M3 | M4 | M5 | M6 | M7 | M8 | M9 | $\widetilde{w}_i$ false |
|---|---|---|---|---|---|---|---|---|---|---|
| M1 | 0.126 | 0.186 | 0.176 | 0.167 | 0.135 | 0.136 | 0.080 | 0.083 | 0.113 | 1.202 |
| M2 | 0.093 | 0.137 | 0.184 | 0.170 | 0.135 | 0.153 | 0.128 | 0.089 | 0.192 | 1.280 |
| M3 | 0.085 | 0.089 | 0.118 | 0.166 | 0.168 | 0.159 | 0.125 | 0.109 | 0.108 | 1.126 |
| M4 | 0.059 | 0.063 | 0.056 | 0.078 | 0.118 | 0.065 | 0.116 | 0.097 | 0.087 | 0.736 |
| M5 | 0.074 | 0.081 | 0.056 | 0.052 | 0.079 | 0.125 | 0.098 | 0.127 | 0.059 | 0.752 |
| M6 | 0.087 | 0.084 | 0.070 | 0.112 | 0.060 | 0.093 | 0.105 | 0.158 | 0.108 | 0.876 |
| M7 | 0.243 | 0.165 | 0.146 | 0.103 | 0.125 | 0.138 | 0.154 | 0.188 | 0.117 | 1.378 |
| M8 | 0.125 | 0.127 | 0.089 | 0.066 | 0.051 | 0.049 | 0.067 | 0.082 | 0.120 | 0.777 |
| M9 | 0.108 | 0.069 | 0.106 | 0.086 | 0.130 | 0.084 | 0.127 | 0.066 | 0.096 | 0.872 |
| $\Sigma_{\bar{a}_{ij}}$ false | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |

*Table 8 Sum Of Expected Demand Layer Index Weights*

| O | O1 | O2 | O3 | O4 | O5 | O6 | O7 | O8 | O9 | O10 | O11 | O12 | O13 | O14 | $\widetilde{w}_i$ false |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| O1 | 0.180 | 0.315 | 0.192 | 0.214 | 0.162 | 0.132 | 0.152 | 0.129 | 0.107 | 0.138 | 0.148 | 0.130 | 0.125 | 0.169 | 2.292 |
| O2 | 0.065 | 0.114 | 0.274 | 0.171 | 0.166 | 0.136 | 0.119 | 0.101 | 0.108 | 0.120 | 0.104 | 0.087 | 0.101 | 0.074 | 1.740 |
| O3 | 0.099 | 0.044 | 0.106 | 0.248 | 0.153 | 0.146 | 0.092 | 0.152 | 0.151 | 0.139 | 0.086 | 0.095 | 0.105 | 0.130 | 1.749 |
| O4 | 0.063 | 0.050 | 0.032 | 0.075 | 0.164 | 0.152 | 0.177 | 0.143 | 0.123 | 0.103 | 0.111 | 0.078 | 0.078 | 0.102 | 1.452 |
| O5 | 0.047 | 0.029 | 0.029 | 0.019 | 0.042 | 0.088 | 0.034 | 0.094 | 0.069 | 0.086 | 0.058 | 0.073 | 0.031 | 0.035 | 0.734 |
| O6 | 0.051 | 0.031 | 0.027 | 0.019 | 0.018 | 0.037 | 0.076 | 0.042 | 0.077 | 0.049 | 0.056 | 0.047 | 0.026 | 0.029 | 0.585 |
| O7 | 0.054 | 0.044 | 0.053 | 0.019 | 0.057 | 0.023 | 0.046 | 0.075 | 0.044 | 0.039 | 0.051 | 0.053 | 0.037 | 0.058 | 0.652 |
| O8 | 0.084 | 0.068 | 0.042 | 0.032 | 0.027 | 0.054 | 0.037 | 0.060 | 0.117 | 0.058 | 0.068 | 0.090 | 0.084 | 0.079 | 0.900 |
| O9 | 0.083 | 0.052 | 0.035 | 0.030 | 0.030 | 0.024 | 0.051 | 0.025 | 0.049 | 0.118 | 0.054 | 0.070 | 0.061 | 0.053 | 0.735 |
| O10 | 0.073 | 0.054 | 0.043 | 0.041 | 0.027 | 0.043 | 0.066 | 0.058 | 0.023 | 0.056 | 0.155 | 0.070 | 0.122 | 0.068 | 0.901 |
| O11 | 0.055 | 0.050 | 0.056 | 0.031 | 0.033 | 0.030 | 0.040 | 0.040 | 0.041 | 0.016 | 0.045 | 0.132 | 0.077 | 0.060 | 0.706 |
| O12 | 0.049 | 0.046 | 0.039 | 0.034 | 0.020 | 0.028 | 0.030 | 0.024 | 0.025 | 0.028 | 0.012 | 0.035 | 0.068 | 0.073 | 0.512 |
| O13 | 0.061 | 0.049 | 0.043 | 0.041 | 0.058 | 0.062 | 0.053 | 0.031 | 0.034 | 0.020 | 0.025 | 0.022 | 0.043 | 0.035 | 0.577 |
| O14 | 0.037 | 0.053 | 0.028 | 0.026 | 0.041 | 0.045 | 0.027 | 0.026 | 0.032 | 0.028 | 0.026 | 0.017 | 0.043 | 0.035 | 0.465 |
| $\Sigma_{\bar{a}_{ij}}$ false | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 1 | |

*Table 9 Consistency Inspection*

| | X | M | O |
|---|---|---|---|
| λmax | 2 | 9.345 | 15.176 |
| CI | 0 | 0.043 | 0.090 |
| RI | 0 | 1.45 | 1.570 |
| CR | 0 | 0.029 | 0.058 |

*Table 10 Calculate The Weight Of Each Factor Of Layer M*

| | M1 | M2 | M3 | M4 | M5 | M6 | M7 | M8 | M9 |
|---|---|---|---|---|---|---|---|---|---|
| $\tilde{w}_i$ false | 1.202 | 1.280 | 1.126 | 0.736 | 0.752 | 0.876 | 1.378 | 0.777 | 0.872 |
| $w_i$ false | 0.134 | 0.142 | 0.125 | 0.082 | 0.084 | 0.097 | 0.153 | 0.086 | 0.097 |

*Table 11 Calculate The Weight Of Each Factor Of Layer O*

| | O1 | O2 | O3 | O4 | O5 | O6 | O7 | O8 | O9 | O10 | O11 | O12 | O13 | O14 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| $\tilde{w}_i$ false | 2.292 | 1.740 | 1.749 | 1.452 | 0.734 | 0.585 | 0.652 | 0.900 | 0.735 | 0.901 | 0.706 | 0.512 | 0.577 | 0.465 |
| $w_i$ false | 0.164 | 0.124 | 0.125 | 0.104 | 0.052 | 0.042 | 0.047 | 0.064 | 0.052 | 0.064 | 0.050 | 0.037 | 0.041 | 0.033 |

According to the results of the above analysis, the demand weight of each factor in layer m of the intelligent pet feeder function is shown in table 10, the demand weight of each factor in layer o is shown in Table 11, and the final important level weight ranking is shown in Table 12. From the second level refers to the standard layer. In terms of ranking, it is m (necessary requirements) > O (expected requirements), indicating that experts pay more attention to the basic functional requirements of products. From three levels, it refers to the sorting of sub criterion layers, which are O1 > M7 > M2 > M1 > M3 > O3 > O2 > O4 > O6 > M6 > M9 > M8 > M5 > M4 > O10 > O8 > O9 > O5 > O11 > O7 > O6 > O13 > O12 > O14. In general, the importance of regular feeding function is the highest, and the importance of voice food change function is the lowest. From the perspective of function classification, remote function > characteristic function > basic function > video function > interactive function.From the perspective of essential requirements (m), M7 (APP timing function), M2 (infrared night vision function) and M1 (1080 video recording function) rank highest. Users feel that the product should have this function and must give priority to meeting it. Providing it will not greatly improve the level of user satisfaction. If it does not, the user satisfaction will be greatly reduced and sorted comprehensively, The sequence is: M7 (APP timing function) > M2 (infrared night vision function) > M1 (cloud 1080 video recording function) > m3 (ultra wide-angle function) > M6 (PET video trigger) > M9 (prevent pet stealing) > M8 (cloud storage function) > M5 (two-way

voice function) > M4 (high definition function).From the perspective of expected demand, the highest ranking of (o) is O1 (regular feeding function), O3 (fresh-keeping function) and O2 (regular feeding function). Comprehensive sorting, The sequence is: O1 (regular feeding function) > O3 (preservation function) > O2 (regular feeding function) > O4 (visual grain bucket function) > O10 (waterproof function) > O8 (easy cleaning function of food basin) > O9 (modular disassembly function) > O5 (interactive function of pet toy Frisbee)) > O11 (small floor area) > O7 (intelligent reminder function) > O6 (intelligent pet companion function) > O13 (regular water change function) > O12 (food shortage prompt function) > o14 (voice calling function). It can be seen that users expect to get this type of function and service, and should give priority to O1 (regular feeding function), O3 (fresh-keeping function) and O2 (regular feeding function). Users feel that the product should have this function. When such functions are met, the user's satisfaction level will increase, and if not, the user's satisfaction will decrease.Mining hidden demand is the core factor of product development. Therefore, from the ranking of expected demand weight, it can be concluded that in addition to meeting the basic functional requirements of products, O1 (regular feeding function), O2 (regular feeding function), O3 (fresh-keeping function) and O4 (visual grain bucket function). Users pay more attention to the characteristic functions of the product, such as O10 waterproof function, O8 food basin easy to clean and O9 modular disassembly function.

*Table 12 Final Importance Ranking*

| Sort order | Importance ranking |
|---|---|
| Kano Model | M>O>A>I |
| AHP weight | M>O |
| Essential requirements M | M7>M2>M1>M3>M6>M9>M8>M5>M4 |
| Expected demand O | O1>O3>O2>O4>O10>O8>O9>O5>O11>O7>O6>O13>O12>O14 |
| Total weight sorting Method | O1>M7>M2>M1>M3>O3>O2>O4>M6>M9>M8>M5>M4>O10>O8>O9>O5>O11>O7>O6>O13>O12>O14 |

According to Kano / AHP analysis, locate the functional design elements of the intelligent feeder, finally select the expected demand elements as the main design scheme, and carry out product modeling design through rhino software. The effect diagram of the design scheme is shown in Figure 4 and the detail diagram of the product scheme is shown in Figure 5. Objective to realize the waterproof function of target users, easy cleaning function of food basin, modular disassembly, APP intelligent control and video monitoring, and optimize the user experience process to solve the problem that the product is not easy to carry, make it easy for users to carry, and make it easier for modular disassembly or assembly. Make it more in line with the behavior characteristics of users and reflect the humanistic care of product design [16].


*Figure 4  Effect drawing of design scheme of intelligent feeder*

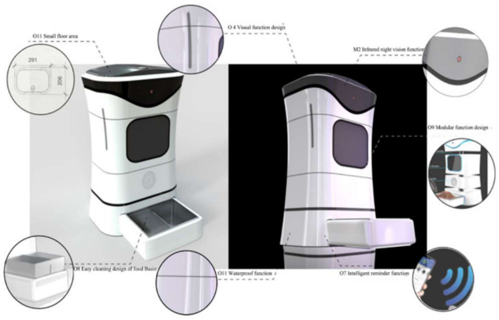


*Figure 5  Details of design scheme of intelligent feeder*

## 6. Conclusion

According to the above conclusions, we can find the optimization and improvement direction of intelligent pet feeder: emotional design can be appropriately added. Emotional design pays more attention to users' Emotional Interactive Experience on the basis of meeting product functions and realizing beautiful appearance [17].The design of intelligent pet feeder can highlight the new features and functions of the product, such as combing function, nursing function, drying function, etc.Fully tap the features of functionality, portability and innovation of products. Smart pet feeders are mostly used by young people, which can further increase the interactive experience of products and make smart pet feeders more intelligent products.

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